Bialkali Photocathode Development at SSL

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GALEX M31

LAPD Photocathode Milestones

• Systematic characterization of Photo-electron Emission (PE) properties of materials for photocathode development.

• Demonstration of an operational 8”-square photo-cathode with a viable path to QE ≥ 15% for wavelengths between 300 and 450 nm.

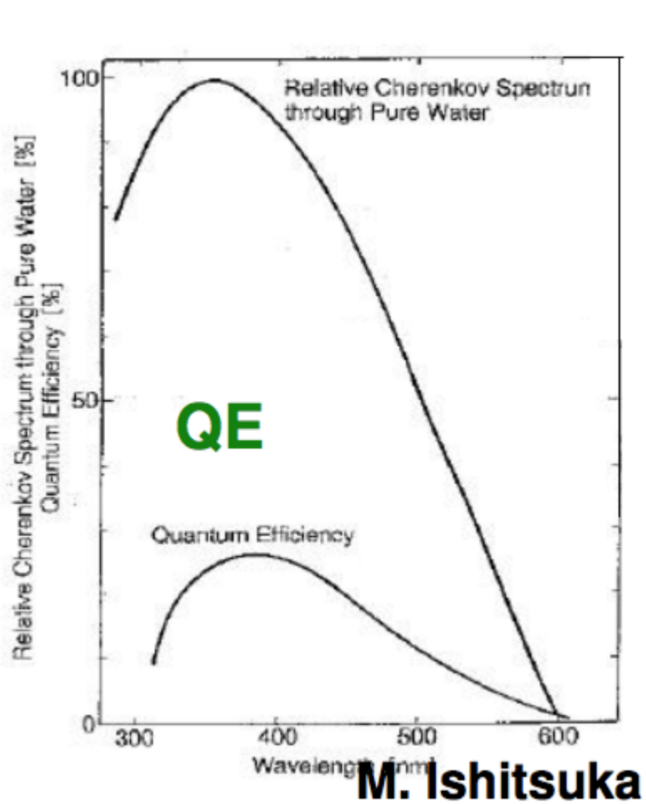
Associated Milestones - Dependencies:-

• Demonstration of the window-to-body seal solution.

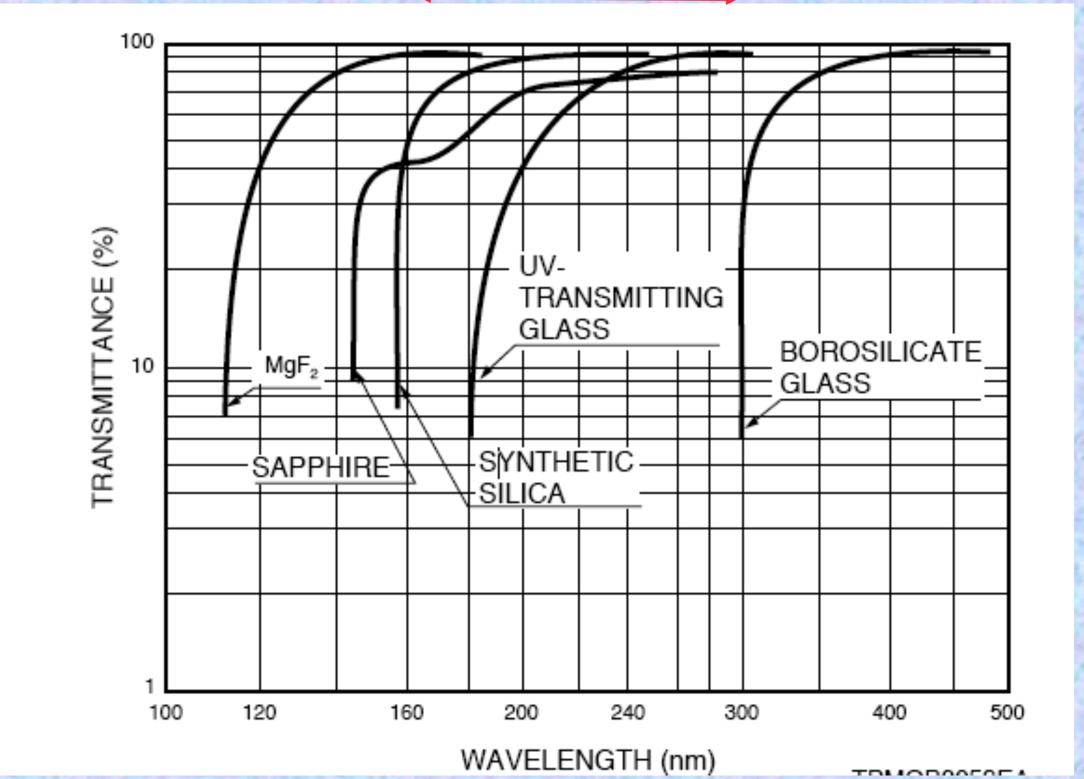
• Design and costing of the vacuum-transfer/assembly facility for the 8”-square MCP module.

Cathode Bandpass and Windows

Acceptable cutoff range



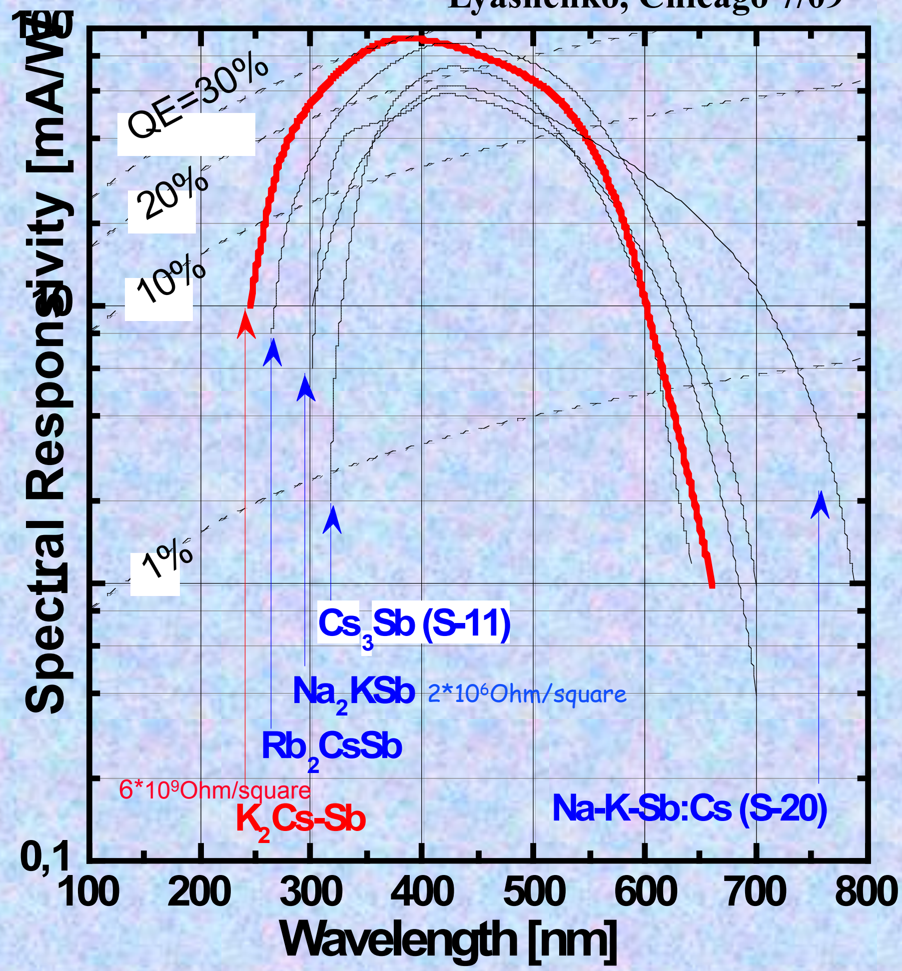
Nominal Cherenkov emission spectrum compared with bialkali

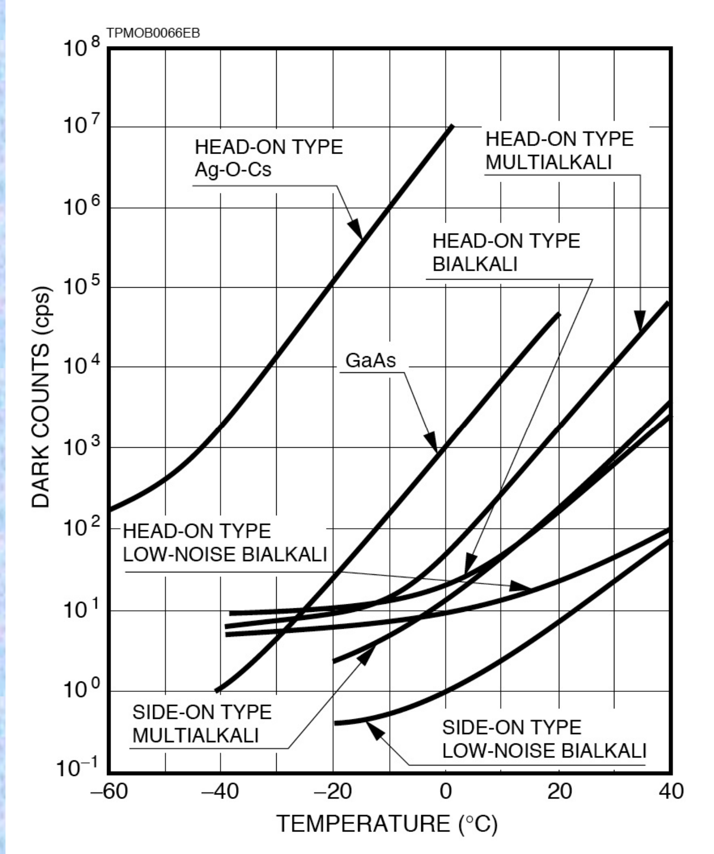


Typical window transmission curves

Bi-Alkali Cathode Characteristics

Lyashenko, Chicago 7/09



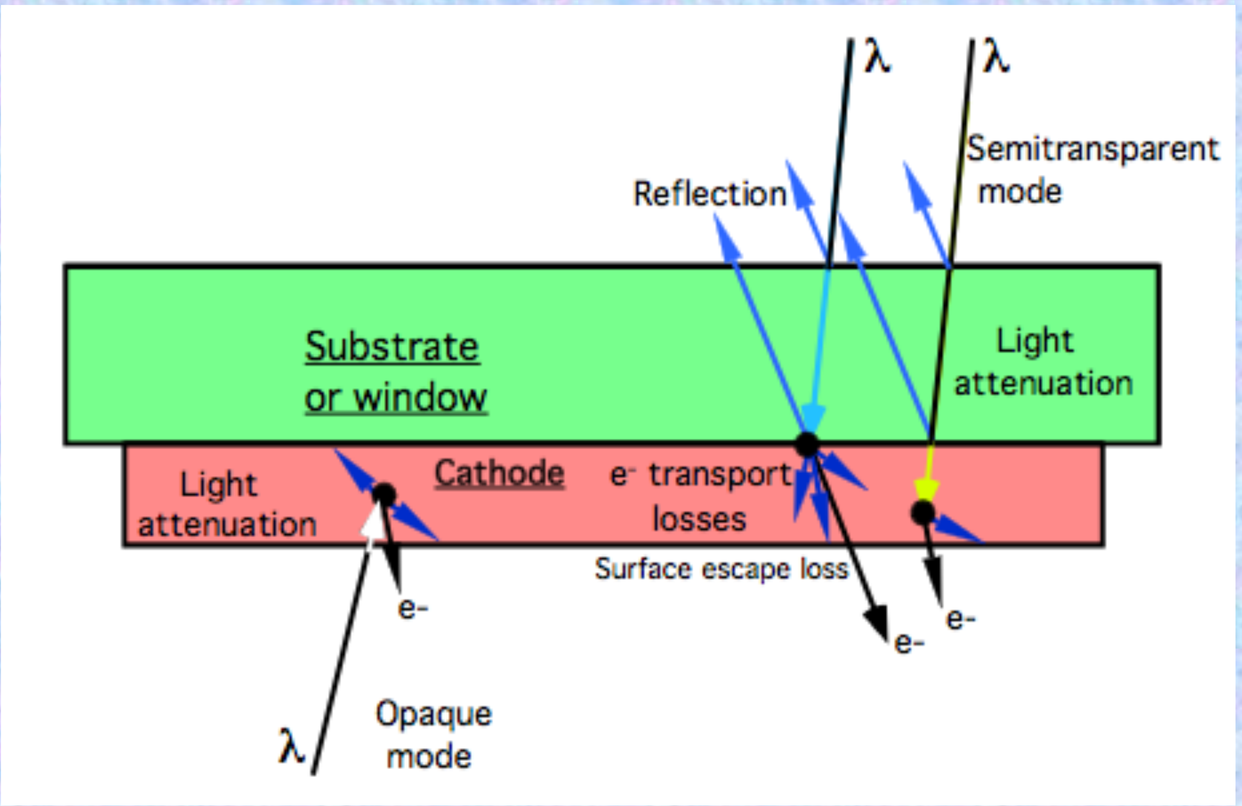


Cathode Noise vs Temp

QE and resistivity for various bialkalis
we will use K_2CsSb & Na_2KSb

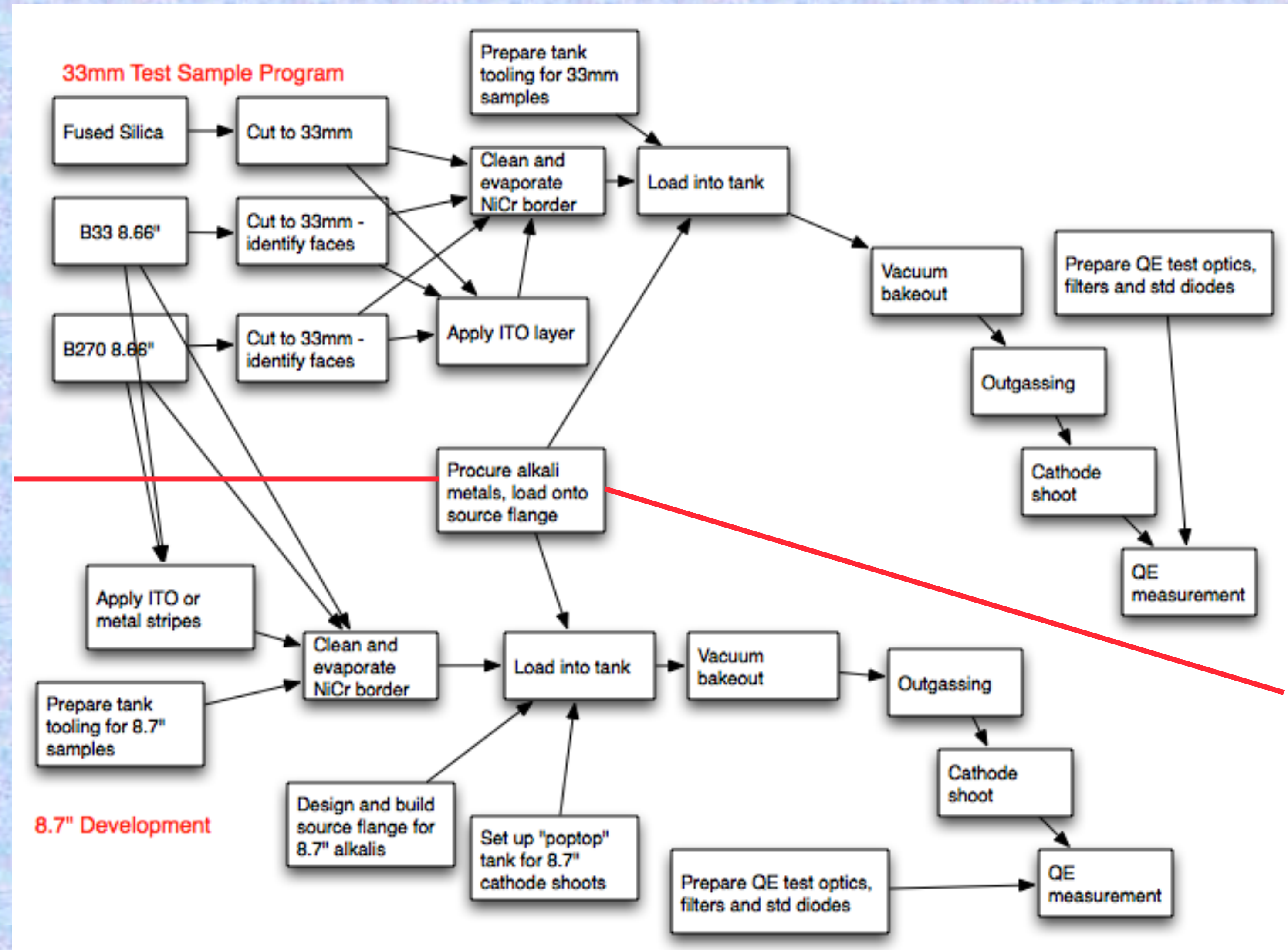
Photocathode Configuration

Numerous processes affect the QE

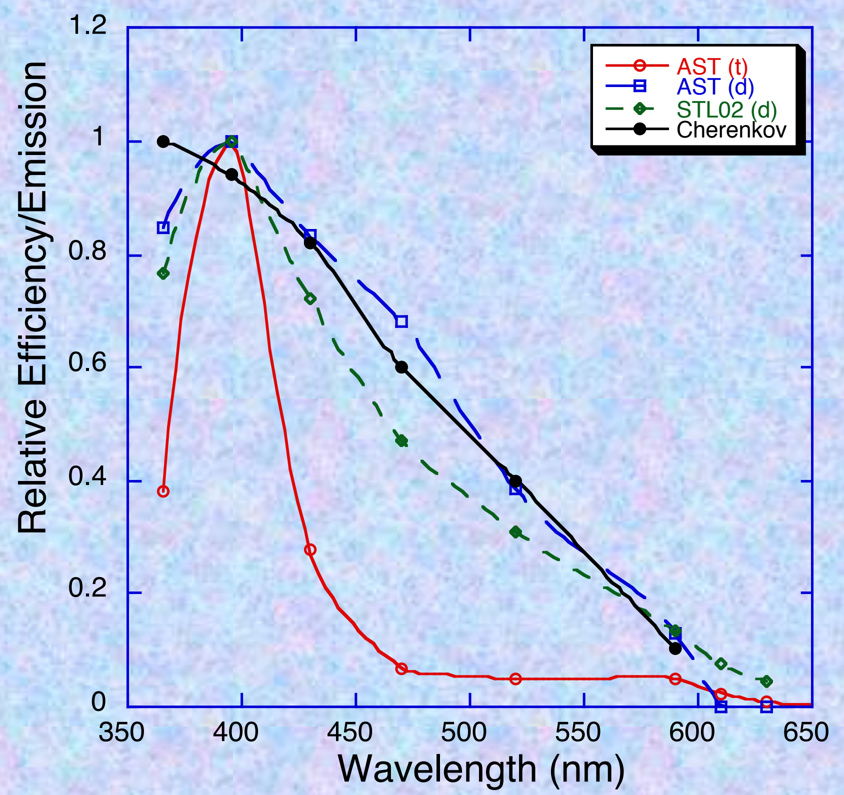


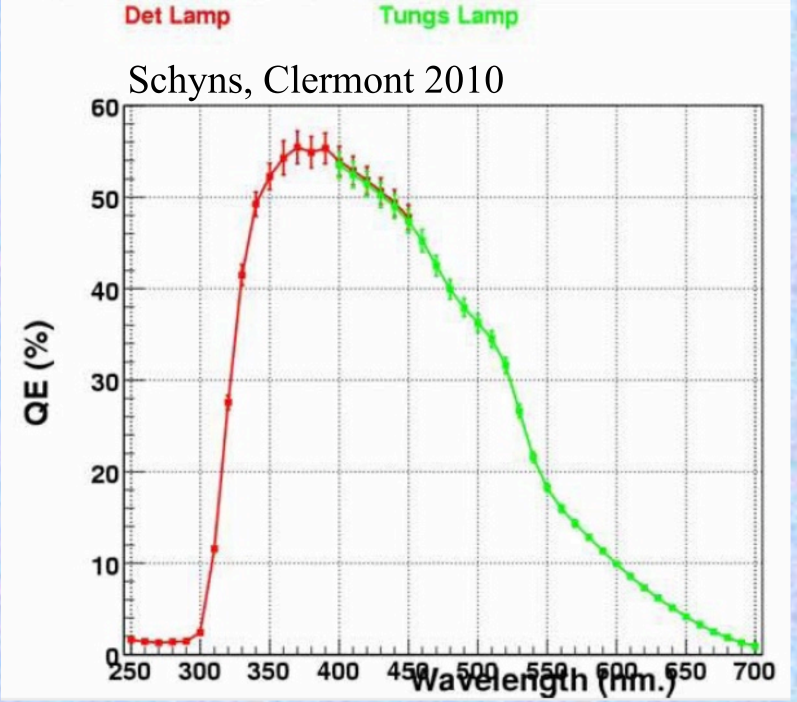
Bialkali is a few 100Å thick, and is compatible with deposition as semitransparent on the window, but is very difficult to achieve as an opaque cathode on the MCP surface.

Work Flow Program for Bialkali Cathode Development



Bialkali Photocathode QE





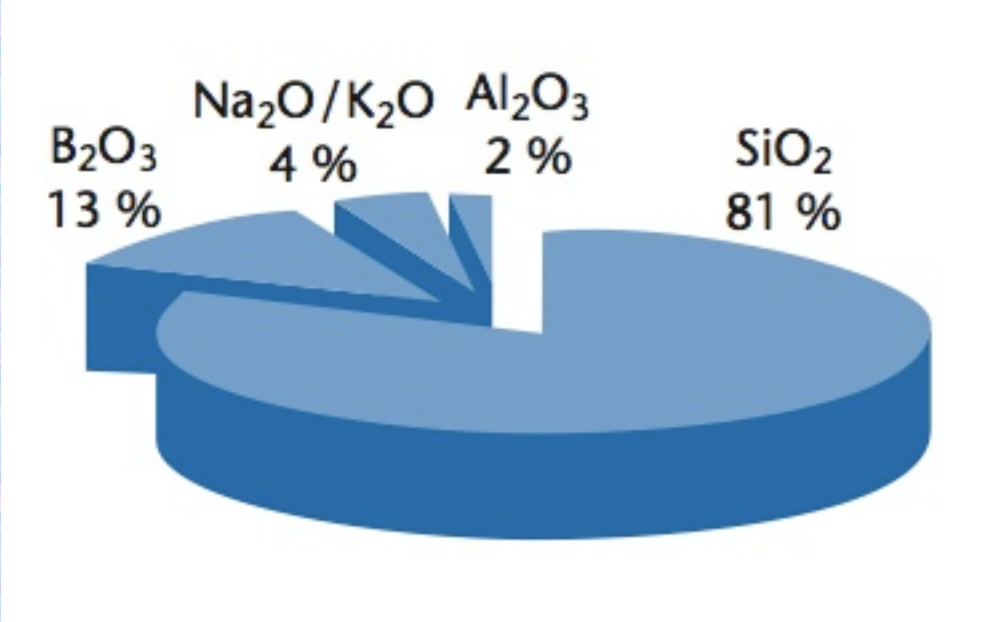
Examples of bialkali photocathode depositions with different wavelength optimizations (on fiber optics). Peak QEs 15% to 21% using Na_2KSb.

High efficiency Bialkali cathodes at Photonis.
May be possible to test using Planacon devices with Incom/ALD MCPs.

Borofloat 33 General Parameters

The cathode substrate, window or window coating, changes the photocathode performance. Quartz, fiber optics, 7056 glass are common. Borosilicate is not, but its quartz and Boron/alkali glass, so should be OK but we need to test this.

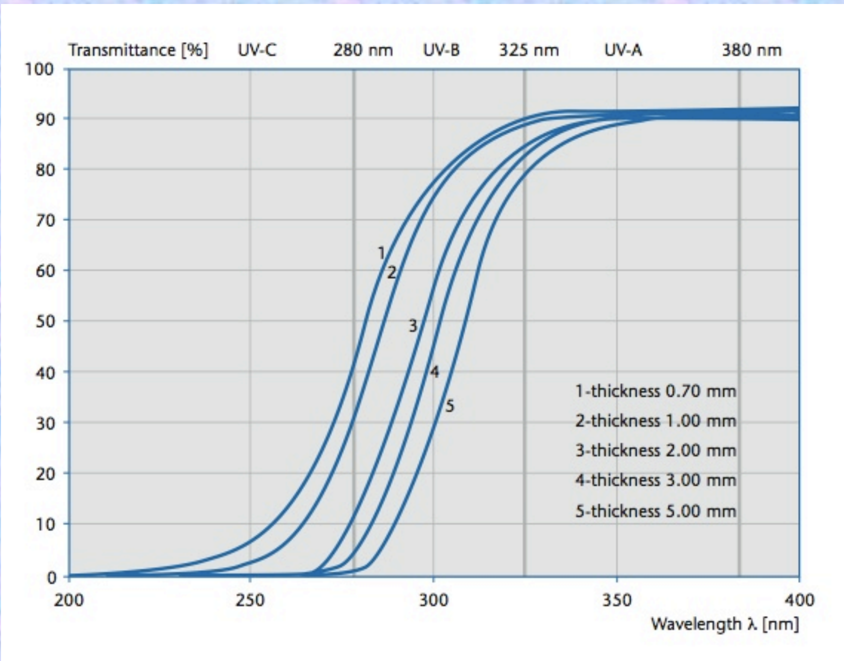
Composition



Refractive index
@400nm

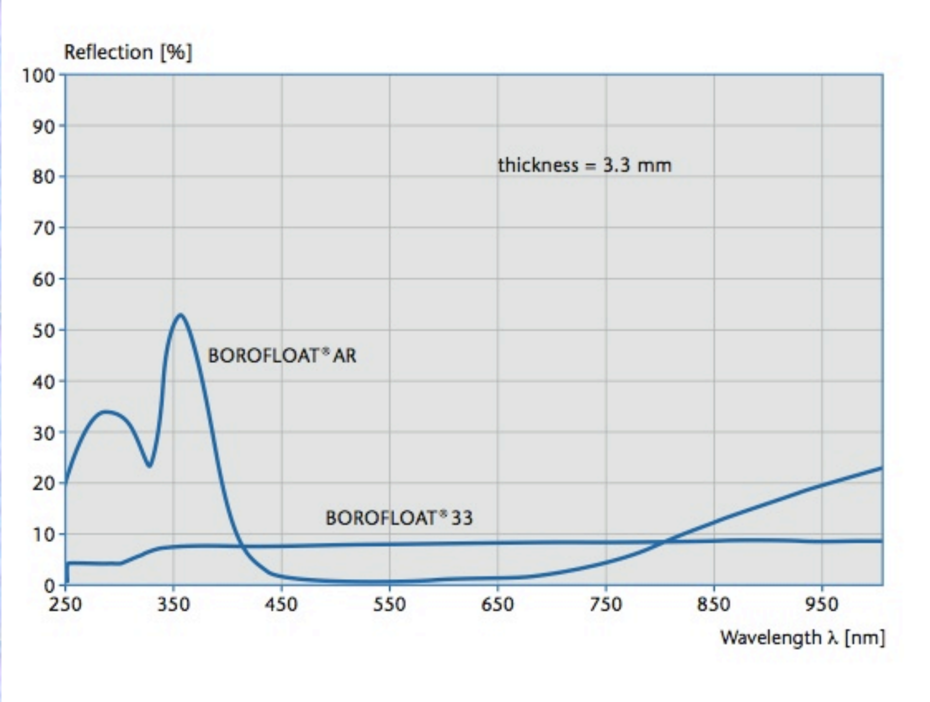
Borofloat 33	**1.47**
Air	**~1.0**
Water	**~1.32**

Transmittance and Reflectance of Borofloat 33



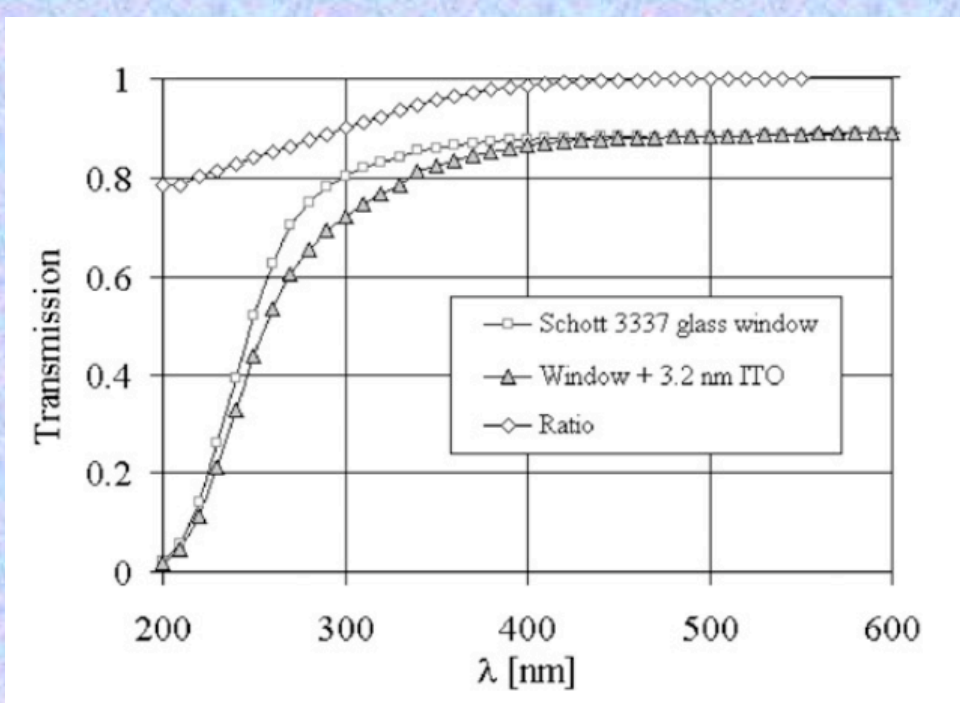
Transmittance is typical for borosilicate glasses, should be OK for LAPD

Standard AR coating is bad for LAPD - most likely don't need AR coating for water/B33 interface



Conductive Layer Properties for Windows

ITO is a possibility for the conductive underlayer, BUT - it might affect the cathode QE! So we can also try metal conductor stripes as we did for GALEX.



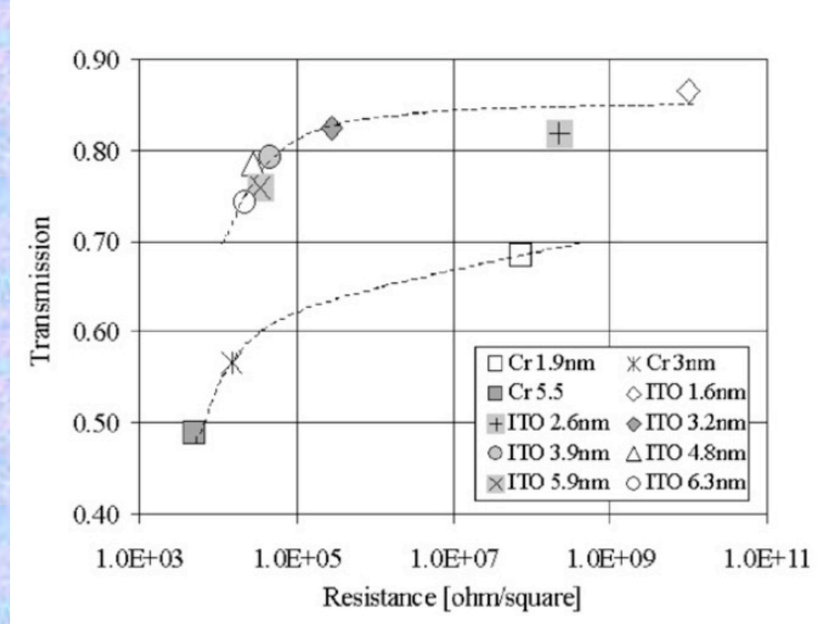


Fig. 4. Measured surface resistance versus average transmission (200–400 nm) of ITO and Cr thin films of various thickness on quartz substrates.

Braem, NIMA 2003

Small Tube and Cathode Process Tank System

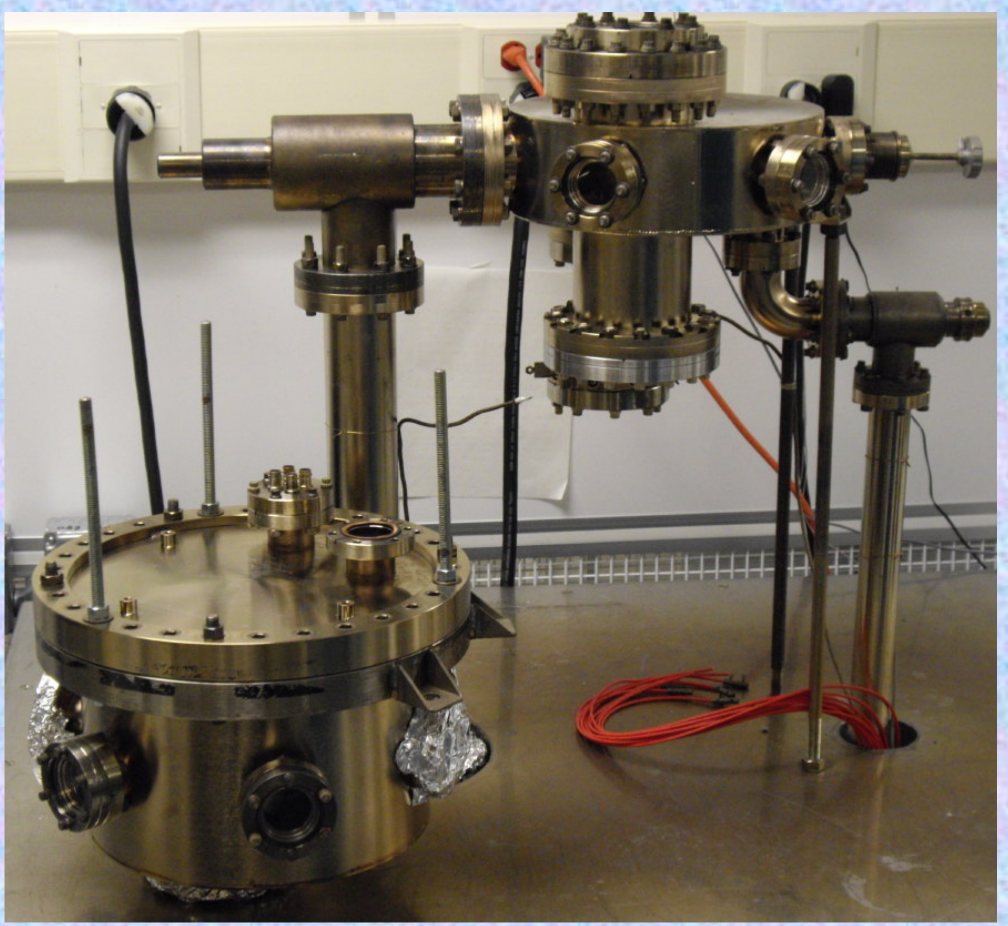
Small window cathode development, 1.3” samples

- Process samples to optimize QE and bandpass
  - Na_2KSb, K_2CsSb cathodes
- Use several substrate materials, verify Borofloat 33/270
- Apply AR coating/processes and test cathodes
- Test metal/ITO conductor underlayer for cathodes
- Test metalization and sealing techniques

Large size window cathode study, 8” windows.

- Study source alkali design for large cathodes
- Develop techniques to make larger area uniform QE
- Optimize cathode QE levels
- Test metal/ITOconductor underlayer for cathodes
- Test metalization and sealing techniques

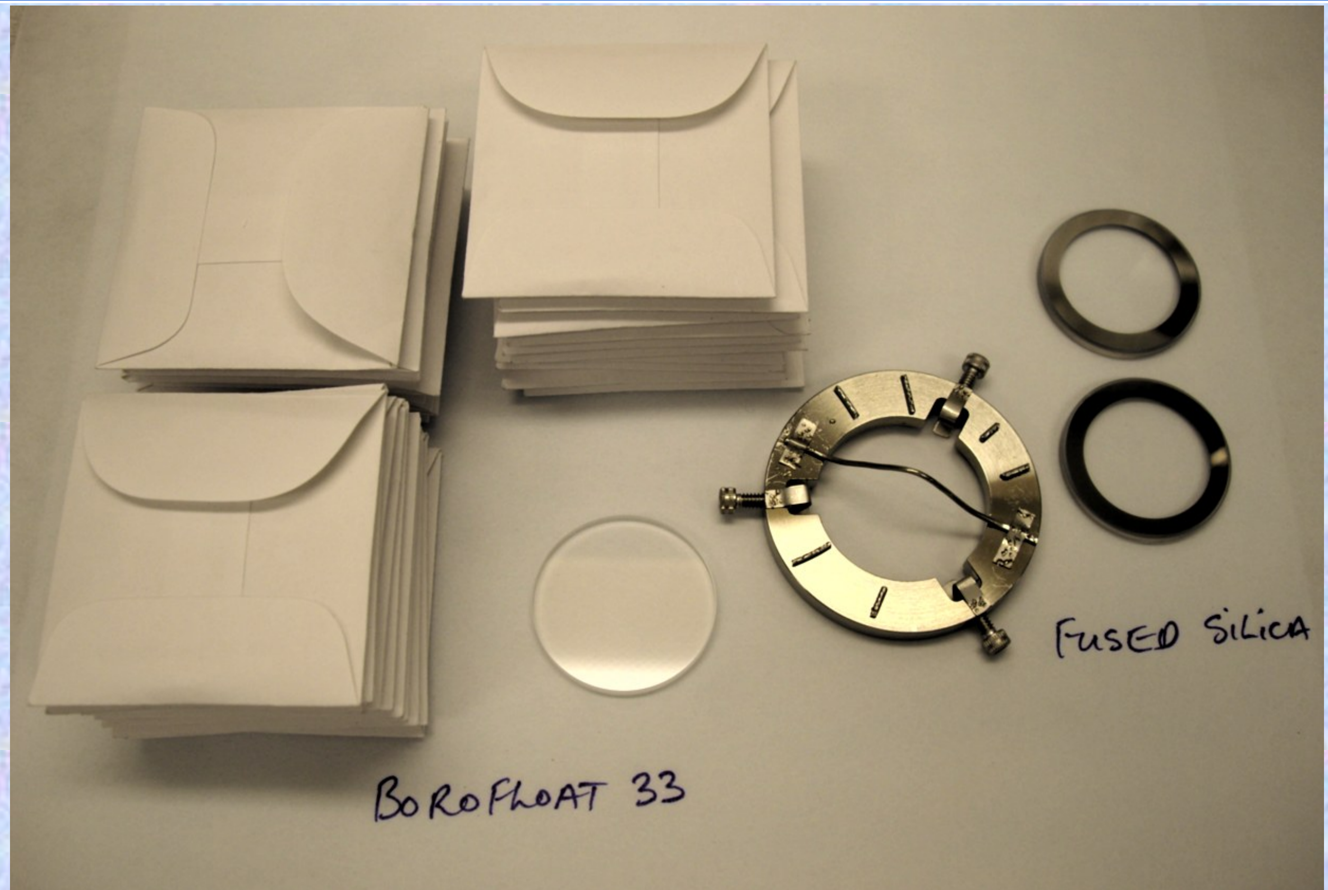
Tube and Cathode Process Test Tank System



Small tank is used to process alkali cathodes (33mm) and tubes of small area.
Can take 4-6 samples/run
- Small sample test runs
- Substrate material tests

Larger 14” flange tank,
can take big windows to test
-Quantum efficiency
-QE Uniformity
-Seal tests
-But there is NO room to move inside

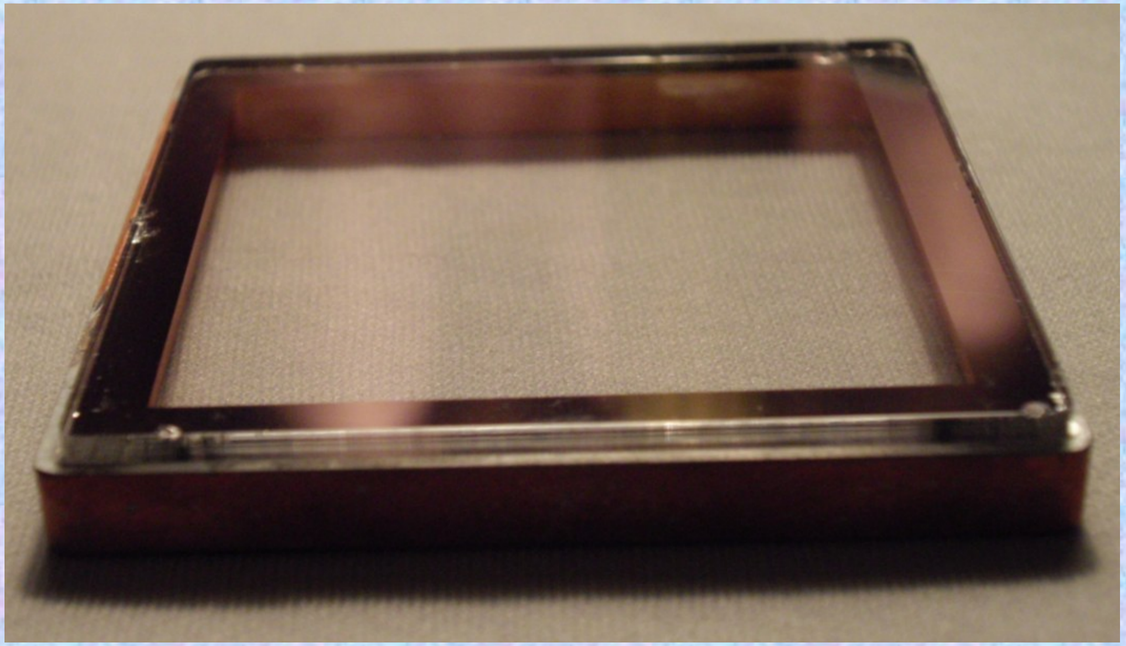
1.3” Cathode Substrates



We have cut up one borofloat 33 window to make 30ea 1.3” test samples, also have 18ea fused silica as control samples.

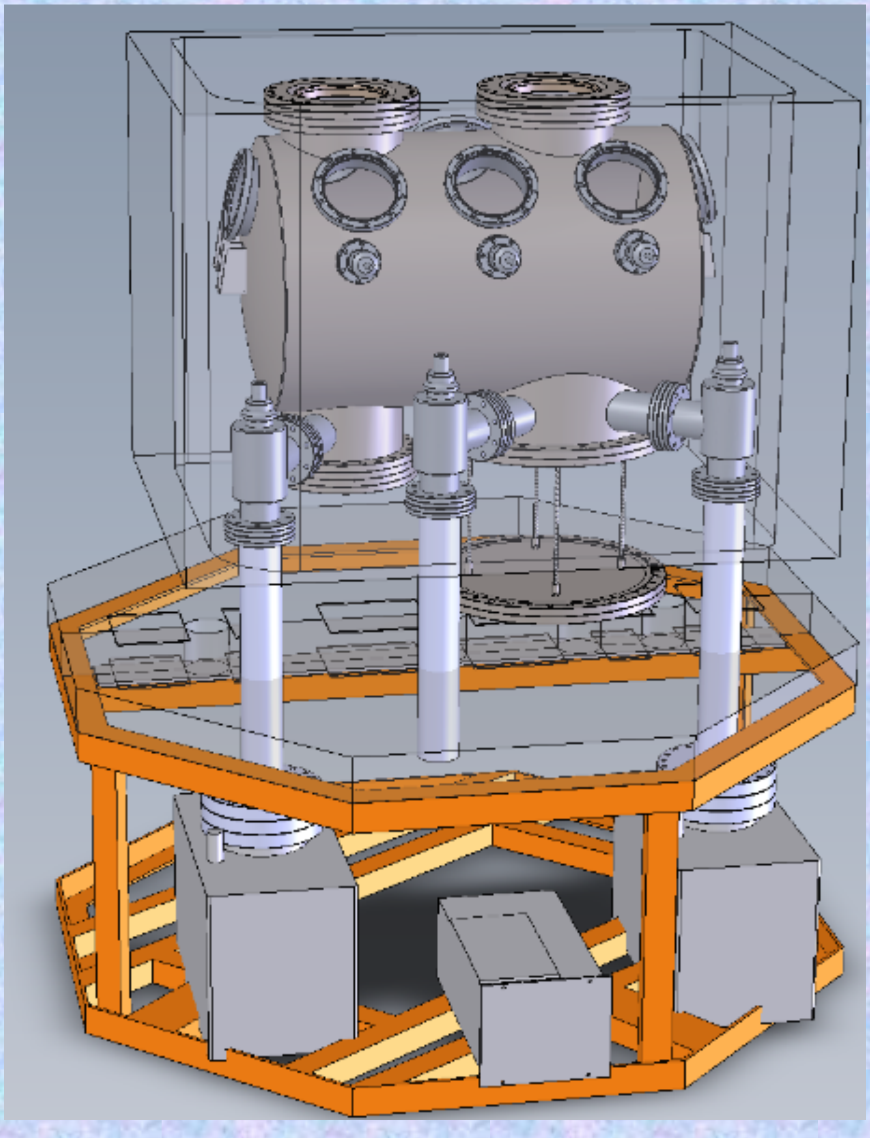
Window Seal Development and Cathode Test "Diodes"

Will metalize 8.7"window and produce an Indium seal on a frame to test leak tightness of the seal.



3" window test article on metal frame with Indium seal

8" Tube and Cathode Process Tank System

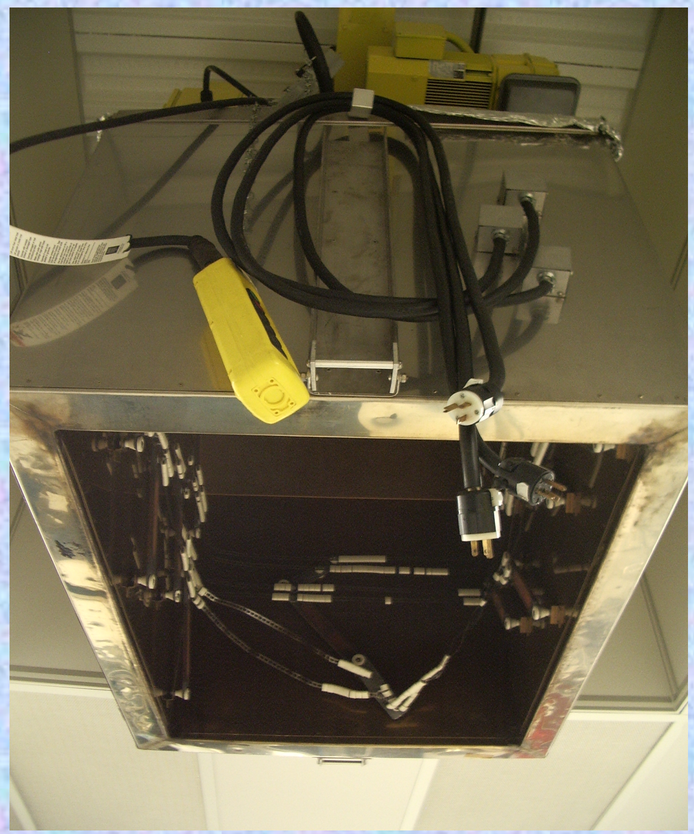


UHV 18" process Chamber:- Initial use for cathode and seal development. Eventually use for complete tube process task.

Borofloat 33/270 8.66" windows

- large area cathodes
- uniformity tests
- QE optimization

Tube Lab, oven and test/process station.



8” Tube and Cathode Process Tank System

Large window cathode development, 8.66” square

- **Implement alkali source design for large cathode areas**
- **Develop wet cleaning and plasma cleaning processes**
- **Establish metalization scheme**
- **Test metal/ITO conductor underlayer for 8” cathodes**
- **Implement AR coatings/treatment on both surfaces**
- **Develop techniques to make 8” area uniform QE**
- **Optimize cathode QE levels**
- **Trial seals on 8.66” “frames”**

- **Then**

- **Make LAPD 8” tubes**

Cathode Development Summary

- Bialkali cathodes are still the standard for the wavelength regime
- Establish Semitransparent Bialkali processes and window treatments on small 1.2” substrates
- Confirm that bialkalis can be deposited on large windows and sealed into leak tight enclosures
- Make trial full up LAPD detector(s)